Analysis of DWT OFDM using Rician Channel and Comparison with ANN based OFDM

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ABSTRACT- As the generation grown up, designing of the wireless communication system towards providing best performance by the services such as high speed of data delivery, high capacity and high bit rate. MC-CDMA (Multi Carrier-Code Division Multiple Access) is a desired technique for such cases, MC-CDMA gives best results by the combination of OFDM (Orthogonal Frequency Division Multiplexing) and CDMA (Code Division Multiple Access). So far OFDM used FFT (Fast Fourier Transform) as a basic building block, due to the intolerable cyclic prefixes OFDM led to the replacement of FFT by suitable transform. In this paper performance of OFDM can be increased by replacing FFT based OFDM by DWT based OFDM with Rician fading channel, analysis can be done using Linear Analysis which reduces the time complexity, increases the bandwidth efficiency and decreases the complexity. The spreading code like Walsh code is used in receiver and transmitter side for spreading the data. Also doing the comparison of DWT based OFDM with ANN against DWT based OFDM with Rician Fading Channel using performance of BER (Bit Error Rate).

Keywords- ANN, DWT, FFT, OFDM, Rician Fading Channel.

1. INTRODUCTION

MC-CDMA is a combination of OFDM and CDMA, allows the system to support multiple user at the same time using same frequency [3]. Widely used in video broadcasting, wireless LAN's, digital audio, fixed wireless access in broadband and in cellular mobile Communication. OFDM is a technique in wireless digital communication and it is an encoding method of digital data on multiple carrier frequencies. In high data rate applications OFDM has been used successfully, Inter symbol interference problem can be easily solved, eliminates the fading effects and enhance the capacity of channel. The combination of both OFDM and CDMA maintains the different data rates and increase the efficiency of bandwidth.

The primary work is based on FFT in which OFDM systems are intolerable due to the generation of cyclic prefixes, results in loss of bandwidth and consumes more time [2]. In Existing system the FFT based OFDM systems are replaced by DWT based, using ANN channel estimation using Levenberg-Marquardt training algorithm using AWGN channel and Rayleigh channel [1]. In proposed system ANN channel is replaced by Rician channel and do the analysis using linear analysis Results in Reduces the time complexity, increases the bandwidth efficiency and increases the performance. Also Comparison of FFT based OFDM and DWT based OFDM and using ANN based Channel and Rician Channel is included in this Paper. There are three modulation techniques in analog communication are amplitude modulation, frequency modulation and phase modulation. In this paper using frequency modulation to achieve the high data rate transmission to increase the performance. In frequency modulation there are many modulation techniques are there like BPSK, QPSK and QAM. Among these three BPSK modulation technique is used, which gives better result than other techniques.
Also doing the comparison of DWT based OFDAM against FFT based OFDM using performance of Bit Error Rate(BER) [4].

This paper is framed by as follows: Section II represents the spreading using Walsh code, Section III describes FFT based OFDM, Section IV describes the DWT based OFDM, Section V describes DWT based OFDM using ANN channel estimation, Section VI Proposed DWT based OFDM using Rician Channel and analyzed using Linear Analysis, Section VII comparison and simulation results, finally Section VII concludes the main outcome of this paper.

II. SPREADING USING WALSH CODE

[5]Spreading is a transmission in which signal occupies the wider bandwidth than the required minimum bandwidth for information transmission. In MC-CDMA spreading codes are major elements which are combined with the transmitted data stream increases the bandwidth requirement. Spreading provides lots of benefits by encoding the transmitted signal. For each information signal using of spreading codes results the co-existence of multiple coded channels at the same time over same frequency. Spreading signals over a wider bandwidth allow its co-existence with narrow band signals. There are two major spreading factors are direct sequence and frequency hopping [4].

Walsh codes are used in direct sequence spread spectrum (DSSS). It is an decodable code which decode the original message with high probability, within a small fraction of received word. Most important property of Walsh code is Orthogonality, provides Zero cross-correlation between any two Walsh-Hadamard codes when the system is

synchronized. Over a binary alphabet Walsh code is a linear code, maps the message of length n to codewords of length 2^n.
Walsh codes are generated by Hadamard matrix with

$$H1=0 \quad (1)$$

Where H1 is 1 X 1 matrix with an order 1. The Hadamard matrix is generated by

$$H_{2n} = \begin{pmatrix} H_n & H_n \\ H_n & \overline{H_n} \end{pmatrix} \quad (2)$$

Hadamard matrix for 2 :

$$H_2 = \begin{pmatrix} 0 & 0 \\ 0 & 1 \end{pmatrix} \quad (3)$$

Hadamard matrix for 4 will be:

$$H_4 = \begin{pmatrix} 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 1 \\ 0 & 0 & 1 & 1 \\ 0 & 1 & 1 & 0 \end{pmatrix} \quad (4)$$

Binary data can be usually map to polar form. 0s are mapped to 1s and 1s are mapped to -1.

$$H_1 = 1 \quad (5)$$

$$H_2 = \begin{pmatrix} 1 & 1 \\ 1 & -1 \end{pmatrix} \quad (6)$$

$$H_4 = \begin{pmatrix} 1 & 1 & 1 & 1 \\ 1 & -1 & 1 & -1 \\ 1 & 1 & -1 & -1 \\ 1 & -1 & -1 & 1 \end{pmatrix} \quad (7)$$

III. FFT BASED OFDM

FFT based transceiver block diagram is shown in the Fig. 1. The digital input data are processed by using M-ary QAM or PSK modulator to mapping of data with N subcarriers and are implemented using IFFT block[6].

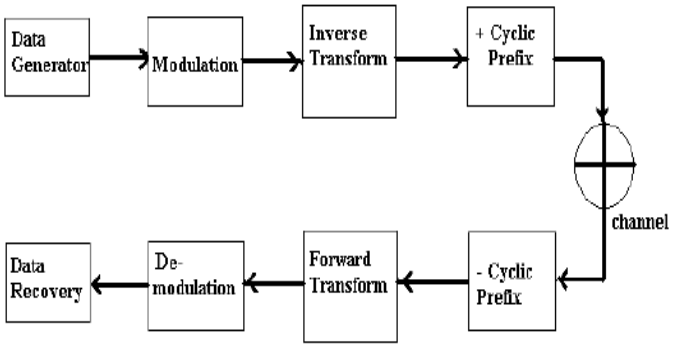

Figure 1. Basic block diagram of FFT based OFDM [2]

Initially the input data is mapped using any of the modulation techniques like BPSK, QPSK and QAM, after the mapping of input data convert the mapped input data into parallel form which is necessary. Each stream of parallel data represents a sub-channel, since serial to parallel converter is used. To modulate the converted data IFFT block is used for stream of low data rate.

The IFFT output is the sum of information signals in the domain of discrete time as following:

$$x_k = \frac{1}{N}\sum_{m=0}^{N-1} X_m e^{j2\pi kn/N} \quad (8)$$

Where $\{xk|0 \le k \le N\text{-}\ 1\}$ is the sequence of discrete time domain, $\{Xm|0 \le m \le N-1\}$ these are complex numbers in the discrete frequency domain using applications of digital modulation method can obtained easily. Applying IFFT to the channels cyclic prefixes will generate, these cyclic prefixes are solved by using Inter Symbol Interference and Inter Carrier Interference [2]. Obtained digital data is then converted to serial form and serial data are transmitted using channel. The receiver receives the data and converted it to serial to parallel form then apply the FFT, using spreading code data are decoded and the final output will be the sum of received signal in discrete frequency domain is as follows:

$$X_m = \sum_{k=0}^{N-1} x_k e^{-\frac{j2\pi km}{N}} \quad (9)$$

Cyclic prefixes in FFT are used to remove the ISI, results in the cause of overhead, these overheads are sometimes more effective to the systems. The block diagram of FFT based OFDM is shown in the Figure 1. The DWT based OFDM is explained in the Next Section.

IV. DWT BASED OFDM

In orthogonality the Discrete Wavelet Transform (DWT) exhibits best results by reducing the complexity of ISI and ICI problem of cyclic prefixes in FFT based OFDM. The CDMA system requires no need of cyclic prefixes which is overcome by using DWT instead of FFT. The block diagram of DWT based OFDM is shown in Fig. 2.

Wavelet transform tool is a combination of time-frequency, which provides information and representation of time and frequency of a signal simultaneously. The usage of wavelet in OFDM reduces FFT based ISI and ICI problem without the use of cyclic prefixes. In the modulation and demodulation transceiver of FFT based OFDM systems are replaced by Inverse Fast Fourier Transform (IFFT) to Inverse Discrete Wavelet

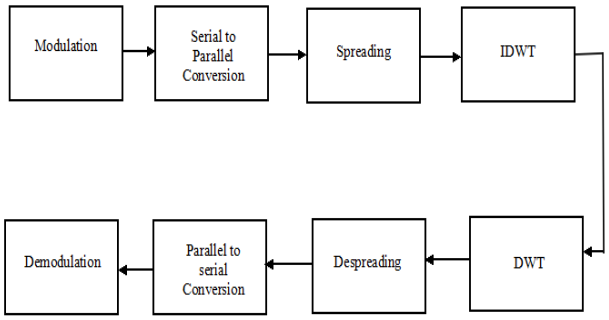

Figure 2. DWT based OFDM

Transform (IDWT) and Fast Fourier Transform (FFT) to Discrete Wavelet Transform (DWT). The outcome of IDWT is represented as follows:

$$d(k) = \sum_{m=0}^{\infty} \sum_{n=0}^{\infty} D_m^n 2^{m/2} \psi(2_k^m - n) \qquad (10)$$

The above equation is an combined Wavelet co-efficient and Wavelet function with compressed factor m times and shifted n times. For each subcarriers [2]. The process is reversed at the receiver side the output of DWT is as follows:

$$D_m^n = \sum_{k=0}^{N-1} d(k) 2^{m/2} \psi(2_k^m - n) \qquad (11)$$

The random binary data is generated at the receiver end, in which received data are modulated using any of the modulation techniques [7]. The ANN based channel estimation is used, which provide the better use of channel state information. The proposed DWT based OFDM using ANN is described in the next section.

V. DWT OFDM USING ANN BASED CHANNEL ESTIMATION

[1] In wireless systems MC-CDMA are optional for high data rate transmission, which is obtained by the combination of OFDM and CDMA systems are considered as an option in wireless system due to the random probability distribution nature and due to some of the existing challenges. A technique called Artificial Nueral Network (ANN) is a learning based tool used for such a cases, are also a thing that is or may be chosen. ANN are preferred for the better use of channel state information. Here based on the Levenberg-Marquardt (LM) training algorithm ANN is used for channel estimation for Multi-antenna setup over a different channel models in MC-CDMA systems.

Feed Forward (FF) mode is used in ANN is trained under multiple channel states. This approach reduces the complexity of the proposed system and no need of matrix computation. Replacing of FFT with DWT increases the performance. Uses FFT which results in the loss of bandwidth, no efficient transmission and not able to manage the different data rates. So here it deals with the Discrete Wavelet Transform (DWT) based application using ANN based chnel estimation instead of Fast Fourier Transform (FFT) due to the attractive properties of DWT.

5.1 Artificial Neural Network (ANN)

In Artificial Intelligence ANN is one of the popular branch. Consists neuron like processing elements. These neuron like elements are connected each other using weight. Weight is adjusted dynamically till the desired output generation for a desired input.The learning based tool like ANN is interconnected artificial neurons packed in multiple layer among these input is the first one and output is the last one in between one or more hidden layers. The general structure of multi layer feed forward ANN is shown in the Fig. 3.

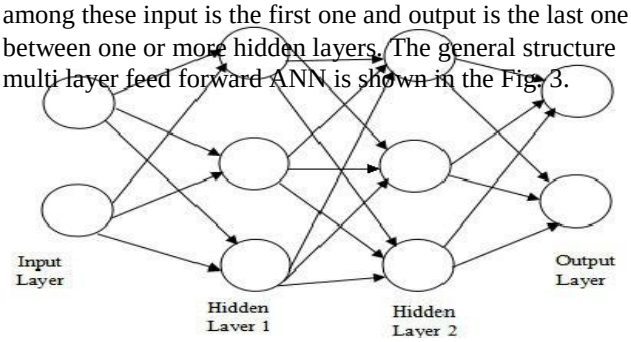

Figure 3. Multi-layer Feed Forward ANN

For the information processing neurons use the linear or nonlinear activation functions. Combined response is obtained by the togetherness of different layers. The difference between the layers and their weights are updated till the expected goal is reached and is called training. ANN in FF mode using Back-Propagation algorithm for training purpose, after training is completed ANN is used for testing purpose [8][9]. The input- output relation of multi-layer FF mode is given as follows:

$$y_k = \phi(\sum_{j=0}^{m} w_{k,j} x_j + b_k). \qquad (12)$$

Where X_j is the input vector, $W_{k,j}$ is the weight vector, b_k is the vector of biases and Y_k is the output vector. The operator *(o)* is the element-by-element activation function for each neuron [3].

5.2. System Architecture for DWT based OFDM using ANN Channel Estimation

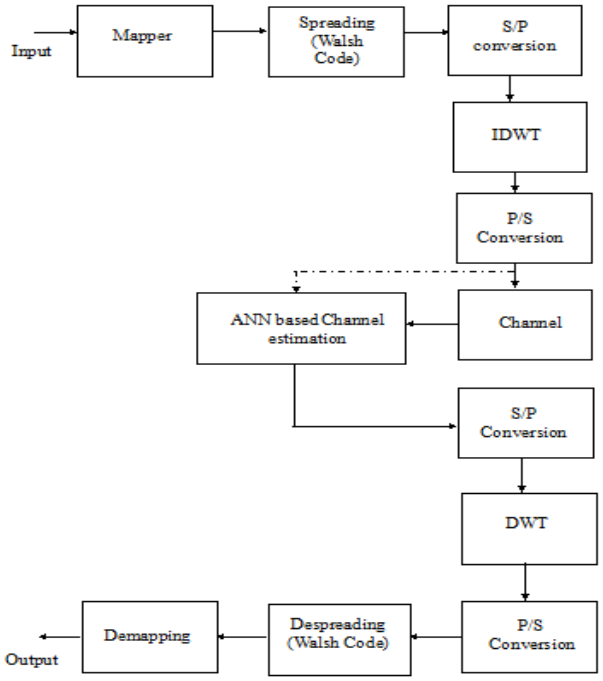

Figure 4. DWT based OFDM using ANN Channel

[8] In the above architecture ANN channel is used for the channel estimation in DWT based OFDM results in the performance increase. Here the system starts from the Mapper which take the bits as input and map the bits using BPSK modulation technique, spreading the modulated data using Walsh Code and converted encrypted data into Serial to Parallel form, apply the IDWT for the obtained data, again convert that data into Parallel to serial, pass those data through the ANN channel as well as Channel and estimate the performance in the ANN channel and reverse the above procedure for the output. Shown in Fig. 4. This estimation can be implement in the matlab ANN tool. In existing system based on the results and analysis it requires more time, which means that increases the time complexity. It is overcome in the proposed system using Rician Channel, results in the reduces the time complexity and increases the performance. Analyzed the result using Linear analysis.

VI. PROPOSED DWT BASED OFDM USING RICIAN CHANNEL AND ANALYZED USING LINEAR ANALYSIS

The related work is for the design of DWT based MC-CDMA in OFDM using Rician Channel for the best performance and to reduces the time complexity faced in the existing system. The below Fig. 5 shows the architecture of DWT based OFDM using Rician Channel and using Linear analysis to analyze the obtained result.

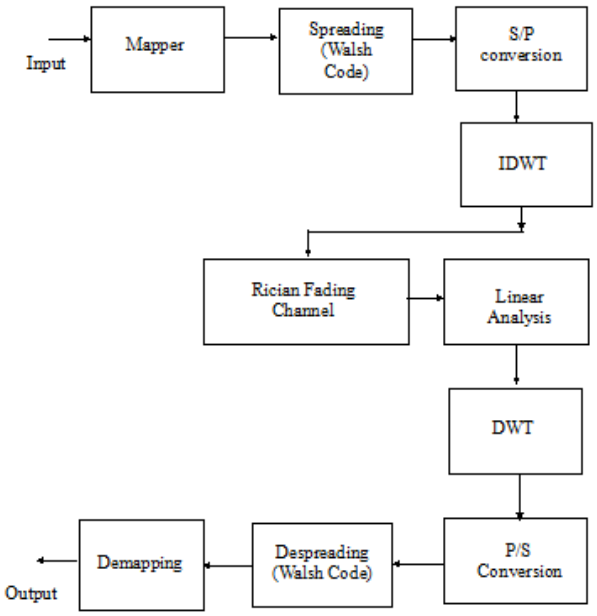

Figure 5. DWT based OFDM using Rician Channel with Linear Analysis

In proposed system MC-CDMA gives the best performance with efficient time by making use of the Rician fading channel and linear analysis. Coming to the working of above architecture, starts with the taking input, it may be any kind of data in this implementation taking bits as an input value and mapping the input using mapper. Mapper includes many techniques used for mapping the data, those techniques are BPSK, QPSK, QAM and etc..among those techniques BPSK used in our implementation for the best results and the mapped data is spreaded using spreading techniques, there are three spreading techniques like Walsh code, PN sequence and gold codes. In the above architecture Walsh code is used for spreading which is nothing but encoding technique and converting the spreading data into serial to parallel transform, for the parallel form of data apply the IDWT transformation technique, the IDWT wavelets are passed to the Rician fading channel which is for the multipath communication with line-of-sight, this Rician channel provides best frequency range led to increase in the performance of channel capacity, transmission range and reduces the time complexity. After estimation in Rician channel give the result to the linear analysis, analyze the result and gives the best linear result for the obtained data. These process happened in the transmission part and same process is reversed in the receiver part for the output data. In the receiver part for analyzed data apply the DWT technique and converting the wavelet into parallel to serial form and despreading is applied, finally demapping using demapper. The result is best performance while transmission, channel capacity reduces the complexity of time and obtain the fading result using BER. This simulation can be done in matlab using Linear analysis tool.

VII. COMPARISON AND SIMULATION RESULT

The comparison and simulation results are executed in proposed system using MATLAB. Fig. 6 shows that mutual information of Rayleigh channel obtained using ANN channel estimation over the SNR to bit error rate, compared using conventional pilot based estimation, ANN estimation (SISO) and ANN estimation (MIMO). Fig. 7 shows the Frequency Response in proposed system using Rician Channel. Fig. 8 gives frequency response in running state using Rician fading channel compared against frequency and magnitude. Fig. 9 shows that Eb/No Vs BER for BPSK over Rician Fading channel with AWGN noise, results in best as compared to the existing system. Fig. 10 shows the Fading Result over BER and SNR using Rician Fading channel. Fig. 11 shows the frequency response estimation for the result obtained in Rician channel over frequency, phase and magnitude. Fig. 12 shows the Linearization results for the obtained frequency estimated result for the linear display of the obtained result against time and amplitude. Based on the simulation result Rician channel is a best channel for transmission in the multipath communication majorly used in mobile communication.

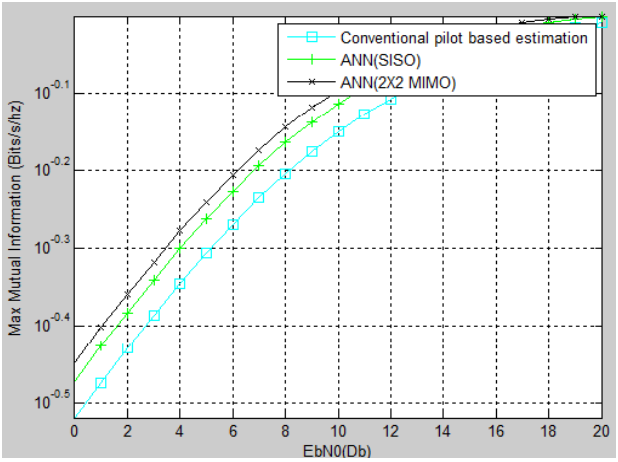

Figure 6. Mutual information in Rayleigh channel using ANN

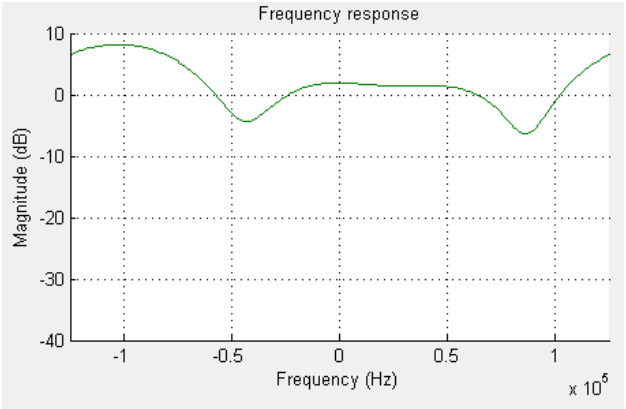

Figure 7. Frequency Response in proposed system using Rician Channel

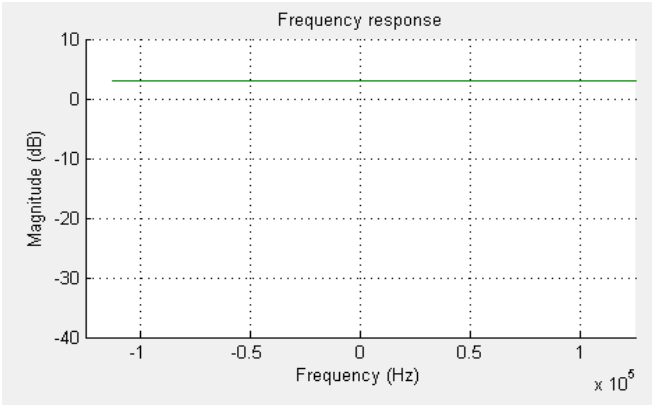

Figure 8. Frequency response in running state

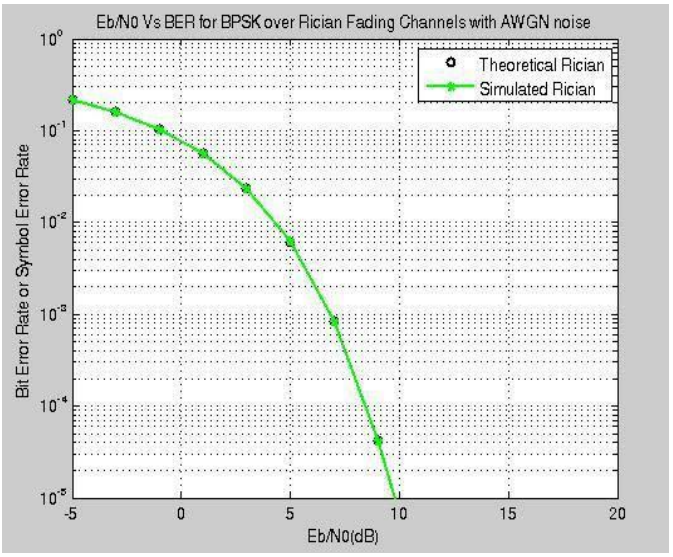

Figure 9. SNR Vs BER over Rician Channel

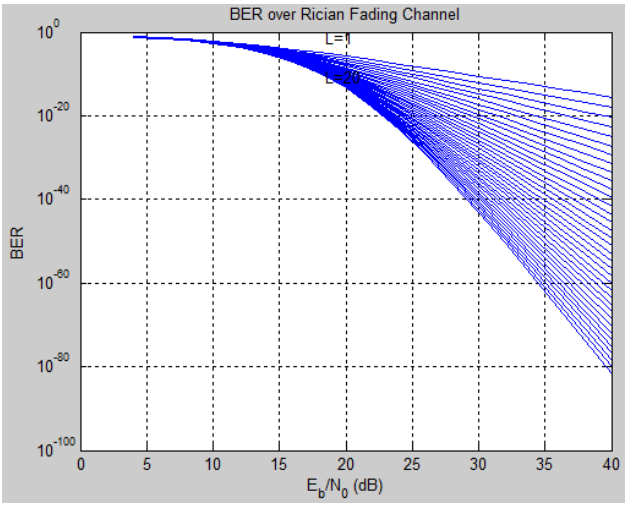

Figure 10. BER over Rician Fading Channel

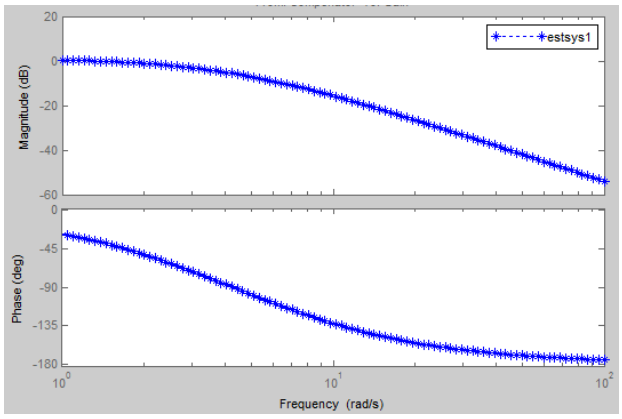

Figure 11. Frequency Response Estimation

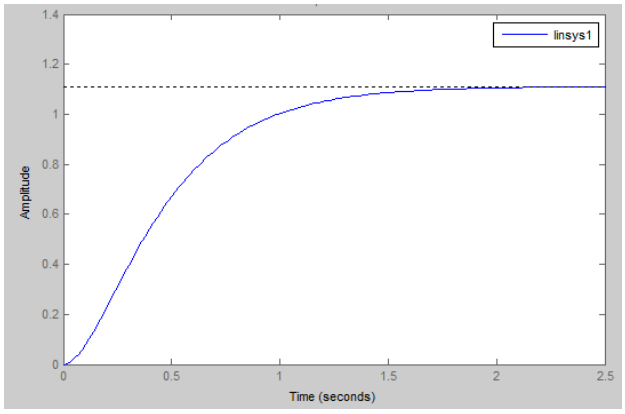

Figure 12. Linearization for Frequency Response Estimation

CONCLUSION

As per the above work studies the DWT based OFDM using ANN and DWT based OFDM using Rician Channel with Linear analysis. The disadvantage of FFT is cyclic prefixes is overcome by using the DWT based OFDM, pilot carrier is removed in the proposed system, BPSK modulation technique is used for the mapping, Walsh code is used for spreading the mapped data, applied IDWT for spreading result and passes through the Rician Channel which is an multipath channel communication results in the best performance, decreases the time complexity, increases the speed of transmission, utilizes the lesser bandwidth and linear analysis tool is used for the linear analysis for the obtained result. Finally conclude these result encourages the further implementation using DWT in the wireless application.

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